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SEMICONDUCTOR DEVICE, METHOD OF MANUFACTURING SAME, AND SEMICONDUCTOR MOUNTING METHOD

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[There are no amendments to this patent.]

Abstract

Purpose

To prevent signal delay due to wiring length in a semiconductor device or semiconductor module having a three-dimensional (3-dimensional) structure by folding up a flexible wiring board. To increase the heat dissipation efficiency.

Constitution

A type of semiconductor device or semiconductor module characterized by the following facts: it has a flexible wiring board that has folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, and at least one set of laminates created by folding said flexible wiring board at said folding portions and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board; wirings having the same function of the laminates are electrically connected by shortcut wiring boards.

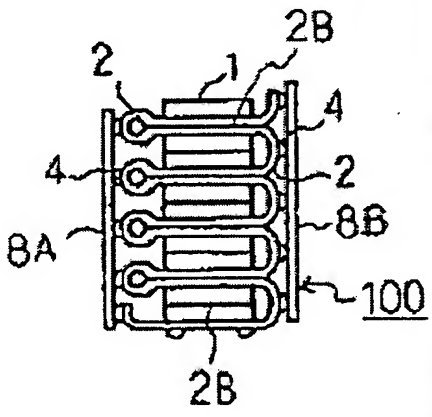


Figure 1

Claims

1. A type of semiconductor device characterized by the fact that it has a flexible wiring board that has double folding portions and allows plural semiconductor chips to be mounted on the first principal surface at prescribed intervals, at least one set of laminates created by folding said flexible wiring board at said double folding portions and thereby superposing adjacent

semiconductor chips mounted on said first principal surface of said flexible wiring board, and shortcut wiring boards that electrically connect wirings having the same function of the laminates.

2. A type of semiconductor device characterized by the fact that it has a flexible wiring board that has double folding portions and allows plural semiconductor chips to be mounted on the first principal surface at prescribed intervals, at least one set of laminates created by folding said flexible wiring board at said double folding portions and thereby superposing adjacent semiconductor chips mounted on said first principal surface of said flexible wiring board, shortcut wiring boards that electrically connect wirings having the same function of the laminates, common terminals for the wirings having the same function of said laminates arranged on the second principal surface of said flexible wiring board, and a means for forming an electrical connection between the common terminals and the wiring lands of the mounting substrate.

3. A method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has double folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface are superposed; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips, the electrical connecting portions being sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said double folding portions so that the adjacent semiconductor chips mounted on the first principal surface of said flexible wiring board are superposed and laminated; and a step in which wirings having the same function of said laminates are electrically connected with shortcut wiring boards.

4. A method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has double folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface are superposed, and which has common terminals for wirings having the same function of said laminates arranged on the second principal surface of said flexible wiring board; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips; a step in which the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said double folding portions so that adjacent semiconductor chips

mounted on the first principal surface of said flexible wiring board are superposed and laminated; a step in which wirings having the same function of said laminates are electrically connected with shortcut wiring boards; and a step in which electrical connection is made between said common terminals and the wiring lands of the mounting substrate.

5. A type of semiconductor device characterized by the fact that it has a flexible wiring board that has double folding portions and allows plural semiconductor chips to be mounted on the first principal surface at prescribed intervals, at least one set of laminates created by folding said flexible wiring board at said double folding portions and thereby superposing adjacent semiconductor chips mounted on said first principal surface of said flexible wiring board, and connecting portions that electrically connect wirings having the same function of the laminates to create wiring shortcuts.

6. A type of semiconductor device characterized by the fact that it has a flexible wiring board that has double folding portions and allows plural semiconductor chips to be mounted on the first principal surface at prescribed intervals, at least one set of laminates created by folding said flexible wiring board at said double folding portions and thereby superposing adjacent semiconductor chips mounted on said first principal surface of said flexible wiring board, shortcut wiring boards that electrically connect wirings having the same function of the laminates, connecting portions that electrically connect wirings having the same function of said laminates to create wirings shortcuts, common terminals for the wirings having the same function of said laminates arranged on the second principal surface of said flexible wiring board, and a means that electrically connects the common terminals and the wiring lands of the mounting substrate.

7. A method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has double folding portions, lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface are superposed and connecting portions for shortcut wirings that create shortcut for wirings having the same function of said laminates; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips, the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said double folding portions so that the adjacent semiconductor chips mounted on the first principal surface of said flexible wiring board are superposed and laminated; and a step in which electrical connection is made for wirings having the same function of said laminates to create wiring shortcuts.

8. A method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has double folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface are superposed, and that has common terminals for wirings having the same function of said laminates arranged on the second principal surface of said flexible wiring board; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips; a step in which the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said double folding portions so that the adjacent semiconductor chips mounted on the first principal surface of said flexible wiring board are superposed and laminated; a step in which electrical connection of wirings having the same function of said laminates is made to create wiring shortcuts; and a step in which electrical connection is made between said common terminals having the same function of said laminates and the wiring lands of the mounting substrate.

9. A type of semiconductor device characterized by the fact that it has a flexible wiring board that has quarter folding portions and allows plural semiconductor chips to be mounted on the first principal surface at prescribed intervals, at least one set of laminates created by folding at said quarter folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface of said flexible wiring board, and connecting portions that electrically connect wirings having the same function of the laminates to create wiring shortcuts.

10. A type of semiconductor device characterized by the fact that it has a flexible wiring board that has quarter folding portions and allows plural semiconductor chips to be mounted on the first principal surface at prescribed intervals, at least one set of laminates created by folding at said quarter folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface of said flexible wiring board, shortcut wiring boards that electrically connect wirings having the same function of the laminates, connecting portions that electrically connect wirings having the same function of said laminates to create wiring shortcuts, common terminals for the wirings having the same function of said laminates arranged on the second principal surface of said flexible wiring board, and a means that electrically connects the common terminals and the wiring lands of the mounting substrate.

11. A method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has quarter

folding portions, lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface are superposed when folding at said quarter folding portions, and connecting portions for the wirings having the same function of said laminates to create wiring shortcuts ; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips, the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said quarter folding portions so that the adjacent semiconductor chips mounted on the first principal surface of said flexible wiring board are superposed and laminated; and a step in which electrical connection is made for wirings having the same function of said laminates to create wiring shortcuts.

12. A method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has quarter folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface are superposed when folding at said quarter folding portions, and that has common terminals for wirings having the same function of said laminates arranged on the second principal surface of said flexible wiring board; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips; a step in which the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said quarter folding portions so that the adjacent semiconductor chips mounted on the first principal surface of said flexible wiring board are superposed and laminated; a step in which electrical connection is made for wirings having the same function of said laminates to create wiring shortcuts; and a step in which electrical connection is made between said common terminals having the same function of said laminates and the lands of the mounting substrate.

13. A type of semiconductor device characterized by the following facts: it has a flexible wiring board that has quarter folding portions or double folding portions and allows plural semiconductor chips to be mounted on the first principal surface at prescribed intervals, at least one set of laminates created by folding at said quarter folding portions or double folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface of said flexible wiring board, and connecting portions that electrically connect wirings having the same function of the laminates to create wiring shortcuts; and a cooling path is provided between laminates with said superposed semiconductor chips.

14. A type of semiconductor device characterized by the following facts: it has a flexible wiring board that has quarter folding portions or double folding portions and allows plural semiconductor chips to be mounted on the first principal surface at prescribed intervals, and at least one set of laminates created by folding at said quarter folding portions or double folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface of said flexible wiring board; the lands for shortcut wiring for wirings having the same function of said laminates are electrically connected, and electrical connection is made between the common terminals of the wirings having the same function of said laminates and the lands on the mounting substrate; in this semiconductor device, a cooling path is provided between the laminates with said superposed semiconductor chips; common terminals having the same function of said laminates are arranged on the second principal surface of said flexible wiring board; and electrical connection is made between said common terminals and the wiring lands of the mounting substrate.

15. A method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has quarter folding portions or double folding portions, lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface are superposed when folding at said quarter folding portions and double folding portions, and connecting portions for wirings having the same function of said laminates to create wiring shortcuts; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips, the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said quarter folding portions or double folding portions so that the adjacent semiconductor chips mounted on the first principal surface of said flexible wiring board are superposed and laminated; a step in which a cooling path is formed by means of thermoconductive adhesive tape and heat absorptive pads between said laminates with said superposed semiconductor chips; a step in which electrical connection is made for wirings having the same function of said laminates to create wiring shortcuts.

16. A method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has quarter folding portions or double folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface are superposed when said quarter folding portions or double folding portions are folded, and which has common terminals for wirings having the same function of said laminates arranged on the second principal surface

of said flexible wiring board; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips; a step in which the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said [quarter folding portions or] double folding portions so that the adjacent semiconductor chips mounted on the first principal surface of said flexible wiring board are superposed and laminated; a step in which electrical connection is made for wirings having the same function of said laminates to create wiring shortcuts; and a step in which electrical connection is made between said common terminals having the same function of said laminates and the lands of the mounting substrate.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention pertains to a surface-mount type of semiconductor device or semiconductor module, and its manufacturing method. In particular, the present invention pertains to an effective technology in which plural semiconductor chips are mounted on a flexible wiring board (flexible wiring substrate) or a leadframe, and the adjacent semiconductor chips, that is, said mounted semiconductor chips, are attached back-to-back, and laminated.

[0002]

Prior art

As a semiconductor device of small size with a and high degree of integration, for example, Japanese Kokai Patent Application No. Hei 9[1997]-181215 proposed a type of semiconductor device characterized by the following facts: there is a package for assembling semiconductor chips in the stacked portions of a flexible wiring board (flexible wiring substrate), and there is also a package (sealed body) for mounting semiconductor chips on the side opposite the side where the external terminals for mounting semiconductor chips (lands for mounting semiconductor chips) on the flexible wiring board are positioned (see: Figures 22-24).

[0003]

Problems to be solved by the invention

After studying the aforementioned prior art, the present inventors have found the following problems. Although said prior art can realize a three-dimensional (3-D) structure with a small footprint and a high degree of integration, it has only a folded planar (two-dimensional) board as the substrate, so that the wiring length is the same as that in the conventional planar

board constitution. Consequently, the problem of signal delay due to the wiring length exists. Also, due to stacking of plural semiconductor chips (IC chips) in a narrow space, it is difficult for the heat generated in the package to dissipate, and defective operation may result. This is undesirable. Also, the solder ball terminals of the BGA (Ball Grid Array) cannot deform differently from the lead terminals, so that cracks or breakage may occur due to deformation or expansion of the mounting substrate.

[0004]

The purpose of the present invention is to provide a technology that can prevent signal delay due to wiring in the semiconductor device or semiconductor module in a three-dimensional (3-D) structure created by folding the board. Another purpose of the present invention is to provide a technology that can increase the heat dissipation efficiency of the semiconductor device or semiconductor module in a three-dimensional (3D) structure created by folding the board. The aforementioned and other purposes, as well as other novel features of the present invention, will be explained in the description and appended figures of the present specification.

[0005]

Means to solve the problems

In the following, a brief account will be presented for the inventions described in the present patent application. The first invention provides a type of semiconductor device characterized by the fact that it has a flexible wiring board that has double folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, at least one set of laminates created by folding at said double folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board, and shortcut wiring boards that electrically connect wirings having the same function of the laminates.

[0006]

The second invention provides a type of semiconductor device characterized by the fact that it has a flexible wiring board that has double folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, at least one set of laminates created by folding at said double folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board, shortcut wiring boards that electrically connect wirings having the same function of the

laminates, common terminals for the wirings having the same function of said laminates arranged on the second principal surface (inner principal surface) of said flexible wiring board, and a means for forming an electrical connection between the common terminals and the wiring lands of the mounting substrate.

[0007]

The third invention provides a method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has double folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) are superposed; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips, the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said double folding portions so that the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) of said flexible wiring board are superposed and laminated; and a step in which wirings having the same function of said laminates are electrically connected with shortcut wiring boards.

[0008]

The fourth invention provides a method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has double folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) are superposed, and which has common terminals for wirings having the same function of said laminates arranged on the second principal surface (inner principal surface) of said flexible wiring board; a step in which electrical connection is made between the lands for mounting plural groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips; a step in which the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said double folding portions so that the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) of said flexible wiring board are superposed and laminated; a step in which wirings having the same function of said laminates

are electrically connected with shortcut wiring boards; and a step in which electrical connection is made between said common terminals and the wiring lands of the mounting substrate.

[0009]

The fifth invention provides a type of semiconductor device characterized by the fact that it has a flexible wiring board that has double folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, at least one set of laminates created by folding at said double folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board, and connecting portions that electrically connect wirings having the same function of the laminates to create wiring for shortcuts.

[0010]

The sixth invention provides a type of semiconductor device characterized by the fact that it has a flexible wiring board that has double folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, at least one set of laminates created by folding at said double folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board, shortcut wiring boards that electrically connect wirings having the same function of the laminates, connecting portions that electrically connect wirings having the same function of said laminates to create wiring shortcuts, common terminals for the wirings having the same function of said laminates arranged on the second principal surface (inner principal surface) of said flexible wiring board, and a means that electrically connects the common terminals and the wiring lands of the mounting substrate.

[0011]

The seventh invention provides a method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has double folding portions, lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) are superposed and connecting portions of wirings for shortcuts that make shortcuts for the wirings having the same function of said laminates; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads)

of the semiconductor chips, the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said double folding portions so that the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) of said flexible wiring board are superposed and laminated; and a step in which electrical connection of wirings having the same function of said laminates is made to create wiring shortcuts.

[0012]

The eighth invention provides a method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has double folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) are superposed, and which has common terminals for wirings having the same function of said laminates arranged on the second principal surface (inner principal surface) of said flexible wiring board; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips; a step in which the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said double folding portions so that the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) of said flexible wiring board are superposed and laminated; a step in which electrical connection is made to create wiring shortcuts for the wirings having the same function of said laminates; and a step in which electrical connection is made between said common terminals having the same function of said laminates and the wiring lands of the mounting substrate.

[0013]

The ninth invention provides a type of semiconductor device characterized by the fact that it has a flexible wiring board that has quarter folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, at least one set of laminates created by folding at said quarter folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board, and connecting portions that electrically connect wirings having the same function of the laminates to create wiring shortcuts.

[0014]

The tenth invention provides a type of semiconductor device characterized by the fact that it has a flexible wiring board that has quarter folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, at least one set of laminates created by folding at said quarter folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board, shortcut wiring boards that electrically connect wirings having the same function of the laminates, connecting portions that electrically connect wirings having the same function of said laminates to create wiring shortcuts, common terminals of the wirings having the same function of said laminates arranged on the second principal surface (inner principal surface) of said flexible wiring board, and a means that electrically connects the common terminals and the wiring lands of the mounting substrate.

[0015]

The eleventh invention provides a method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has quarter folding portions, lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) are superposed when folding at said quarter folding portions, and connecting portions for wirings having the same function of said laminates to create wiring shortcuts; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips, the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said quarter folding portions so that the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) of said flexible wiring board are superposed and laminated; and a step in which electrical connection is made for wirings having the same function of said laminates to create shortcuts.

[0016]

The twelfth invention provides a method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has quarter folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) are

superposed when folding at said quarter folding portions, and which has common terminals of wirings having the same function of said laminates arranged on the second principal surface (inner principal surface) of said flexible wiring board; a step in which electrical connection is made between the lands for mounting groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips; a step in which the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said quarter folding portions so that the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) of said flexible wiring board are superposed and laminated; a step in which electrical connection is made for wirings having the same function of said laminates to create wiring shortcuts; and a step in which electrical connection is made between said common terminals having the same function of said laminates and the lands of the mounting substrate.

[0017]

The thirteenth invention provides a type of semiconductor device characterized by the following facts: it has a flexible wiring board that has quarter folding portions or double folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, at least one set of laminates created by folding at said quarter folding portions or double folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board, and connecting portions that electrically connect wirings having the same function of the laminates to create wiring shortcuts; and a cooling path is provided between laminates with said superposed semiconductor chips.

[0018]

The fourteenth invention provides a type of semiconductor device characterized by the following facts: it has a flexible wiring board that has quarter folding portions or double folding portions and allows plural semiconductor chips to be mounted on the first principal surface (outer principal surface) at prescribed intervals, and at least one set of laminates created by folding at said quarter folding portions or double folding portions of said flexible wiring board and thereby superposing adjacent semiconductor chips mounted on said first principal surface (outer principal surface) of said flexible wiring board; the lands for shortcut wiring for wirings having the same function of said laminates are electrically connected, and electrical connection is made between the common terminals of the wirings having the same function of said laminates and the lands on the mounting substrate; in this semiconductor device, a cooling path is provided between the laminates with said superposed semiconductor chips; common terminals having the

same function of said laminates are arranged on the second principal surface (inner principal surface) of said flexible wiring board; and electrical connection is made between said common terminals and the wiring lands of the mounting substrate.

[0019]

The fifteenth invention provides a method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has quarter folding portions or double folding portions, lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) are superposed when folding at said quarter folding portions and double folding portions, and connecting portions for wirings having the same function of said laminates to create wiring shortcuts, is prepared; a step in which electrical connection is made between the lands for mounting plural groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips, the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible wiring board is folded at said quarter folding portions or double folding portions so that the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) of said flexible wiring board are superposed and laminated; a step in which a cooling path is formed by means of thermoconductive adhesive tape and heat absorptive pads between said laminates with said superposed semiconductor chips; a step in which electrical connection is made for wirings having the same function of said laminates to create the wiring shortcuts.

[0020]

The sixteenth invention provides a method of manufacturing semiconductor devices characterized by the fact that it has the following steps: a step in which a flexible wiring board is prepared that has quarter folding portions or double folding portions and lands for mounting semiconductor chips corresponding to at least one set of laminated semiconductor chips at the positions where the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) are superposed when said quarter folding portions or double folding portions are folded, and which has common terminals for wirings having the same function of said laminates arranged on the second principal surface (inner principal surface) of said flexible wiring board; a step in which electrical connection is made between the lands for mounting plural groups of semiconductor chips and the external electrodes (pads) of the semiconductor chips; a step in which the electrical connecting portions are sealed with a sealant, and the semiconductor chips are mounted on the flexible wiring board; a step in which said flexible

wiring board is folded at said [quarter folding portions or] double folding portions so that the adjacent semiconductor chips mounted on the first principal surface (outer principal surface) of said flexible wiring board are superposed and laminated; a step in which electrical connection is made for wirings having the same function of said laminates to create wiring shortcuts; and a step in which electrical connection is made between said common terminals having the same function of said laminates and the lands of the mounting substrate.

[0021]

Embodiments of the invention

In the following, an explanation will be given in detail regarding the embodiments (Application Examples) of the present invention, with reference to figures. The same part numbers are adopted throughout all of the figures used to illustrate the application examples, and they will not be explained repeatedly.

[0022]

Application Example 1

Figure 1 is a schematic front view illustrating the constitution of the semiconductor device in Application Example 1 of the present invention. Figure 2 is a front view illustrating the state in which the semiconductor device of Application Example 1 is mounted on a mounting substrate. As shown in Figure 1, in the semiconductor device of Application Example 1, plural semiconductor chips (IC chips) (1) are mounted at a prescribed interval on the outer principal surface (first principal surface) of flexible wiring board (2) having double folding portions. When said flexible wiring board (2) is folded at said double folding portions, adjacent semiconductor chips (1) mounted on the outer principal surface of said flexible wiring board (2) are superposed back-to-back, and adhesive (or adhesive tape) (2B) is used to fix them together. In addition, said flexible wiring board (2) is folded at said double folding portions (2A), and the next set of laminates are layered. In this way, plural sets of laminates are formed. Wiring with the same function of said laminates of said plural sets of laminates are electrically connected with shortcut wiring board (8) to reduce the wiring length of said flexible wiring board (2). Said flexible wiring board (2) has a thickness of, for example, 75 μm, and the Cu wiring has a thickness of, for example, 35 μm.

[0023]

As shown in Figure 2, for semiconductor device (100) of Application Example 1, electrical connection is made between mounting solder ball terminals (common wiring terminals) (7) provided on the inner principal surface (second principal surface) of said flexible wiring

board (2) and lands (9A) for semiconductor device mounting on mounting substrate (9), so that the semiconductor device is mounted on said mounting substrate (9).

[0024]

In the following, an explanation will be given regarding the method of manufacturing the semiconductor device in Application Example 1. Figure 3 is a outer plan view illustrating the wiring constitution of said flexible wiring board (2). Figure 4 is an inner plan view illustrating the wiring constitution of said flexible wiring board (2). Figure 5 is an overall plan view illustrating the state in which semiconductor chips (1) are mounted on said flexible wiring board (2). Figure 6 is a side view of Figure 5. Figure 7 is a cross section illustrating the state in which one semiconductor chip (1) is mounted on said flexible wiring board (2). Figure 8 is a plan view illustrating the wiring constitution of wiring board (8A) as one of said shortcut wiring boards (8A), (8B), and of the other wiring board (8B). Figure 9 is a diagram illustrating the state in which wiring board (8A), one of said shortcut wiring boards (8A), (8B), is connected to the wiring of said flexible wiring board (2).

[0025]

In Figures 3-9, (1) represents semiconductor chips (IC chips); (1A) represents the external electrodes of the semiconductor chips (Au bumps on the pads); (2) represents the flexible wiring board (flexible wiring substrate); (2A) represents the double folding portions; (3) represents wiring; (4) represents Au bumps for connection of shortcut wiring; (5) represents via; (6) represents lands for mounting the semiconductor chips; (7) represents solder ball terminals for mounting (external common wiring terminals); (8A), (8B) represent shortcut wiring boards; (8A1), (8B1) represent shortcut wiring lands; (9) represents a mounting substrate; (9A) represents lands for mounting of semiconductor device on the mounting substrate; (10) represents a sealant; (11) represents flexible board tape; and (12) represents an insulating film (protective film).

[0026]

First of all, flexible wiring board (flexible wiring substrate) (2) is manufactured as shown in Figure 3. As shown in Figure 3, when said flexible wiring board (flexible wiring substrate) (2) is manufactured, wiring is formed on flexible substrate tape (11), with insulating film (protective film) (12) covering it. On the outer principal surface of flexible substrate tape (11) with wiring formed on it as described, wiring (3) for connecting lands (6) for mounting semiconductor chips that have the same function on semiconductor chips (1), Au bumps (4) for shortcut wiring connection that connect lands (6) for mounting semiconductor chips that have the same function

on semiconductor chips (1), via (5) to let said wiring (3) pass through, and lands (6) for mounting semiconductor chips are formed at their respective positions. as shown in Figure 4, wiring (3) for connecting lands (6) for mounting semiconductor chips that have the same function on semiconductor chips (1), as well as Au bumps (4) for shortcut wiring connection and solder ball terminals (external common wiring terminals) (7) for mounting are formed on the inner principal surface of said flexible substrate tape (11).

[0027]

In the method of manufacturing the semiconductor device in Application Example 1, as shown in said Figure 3, a flexible wiring board (flexible wiring substrate) (2) is prepared. Then, as shown in Figures 5 and 6, external electrodes of the semiconductor chips (Au bumps on the pads) (1A) are electrically connected with lands (6), which are for mounting semiconductor chips and are formed at a prescribed interval on the outer principal surface of said flexible wiring board (2), in order to mount plural semiconductor chips (IC chips) (1). That is, as shown in Figure 7, for semiconductor chips (IC chips) (1), external electrodes (Au bumps on the pads) (1A) and lands (6) for mounting the semiconductor chips, are electrically connected, followed by sealing of the connection region with sealant (sealing resin) (10).

[0028]

As shown in Figure 6, said flexible wiring board (2) having said plural semiconductor chips (1) mounted on it is folded at said double folding portions (2A) in the direction indicated by arrows. As a result, adjacent semiconductor chips (1) mounted on the outer principal surface of said flexible wiring board (2) are superposed back-to-back, and they are fixed together with adhesive (or adhesive tape) (2B). Said flexible wiring board (2) is further folded at said double folding portions (2A), Au bumps (4) for shortcut wiring connection and lands (4A) for shortcut wiring connection are [electrically] connected, and the next sets of laminates are layered on. In this way, plural sets of laminates are formed.

[0029]

As shown in Figure 9, first of all, by means of shortcut wiring board (8A) shown in Figure 8(a), wirings having the same functions of said laminates of said plural sets of laminates are electrically connected to Au bumps (4) for shortcut wiring connection of wirings having the same function on the left side of the laminates. Then, shortcut wiring lands (8B1) of shortcut wiring board (8B) shown in Figure 8(b) are electrically connected to Au bumps (4) for shortcut wiring connection of wirings having the same function on the right side of the laminates. As a result, the wiring length of said flexible wiring board (2) can be reduced. As shown in Figure 1,

semiconductor device (100) is completed in this way. As shown in Figure 2, in said semiconductor device (100) electrical connection is performed between solder ball terminals for mounting (common wiring terminals) (7), as the common terminals for wirings of the laminates having the same function, and lands (9A) on mounting substrate (9) for semiconductor device assembly.

[0030]

As explained above, according to Application Example 1, flexible wiring board (2) that can be folded enables electrical connection to be performed for wirings of the laminates having the same function by means of shortcut wiring boards (8A), (8B), and the wiring length of said flexible wiring board (2) is reduced. Consequently, it is possible to prevent signal delay due to the wiring length. Also, in a semiconductor device having a three-dimensional (3D) structure created by folding the wiring board, it is possible to increase the efficiency of heat dissipation for heat generated inside the laminates by means of shortcut wiring boards (8A), (8B) for said wirings having the same function of the laminates. Also, it is possible to realize double-sided assembly of IC chips on both surfaces of the board, rather than at the solder ball terminal regions for mounting.

[0031]

Application Example 2

Figure 10 is a front view illustrating schematically the constitution of the semiconductor device of Application Example 2 of the present invention. Figure 11 is a front view of the semiconductor device of Application Example 2 mounted on the mounting substrate. The semiconductor device in Application Example 2 is an application example in which the shortcut wiring boards (8A), (8B) of said Application Example 1 are omitted. That is, as shown in Figure 10, said flexible wiring board (2) having said plural semiconductor chips (IC chips) (1) mounted on it at prescribed intervals on the outer principal surface of said flexible wiring board (2) having folding portions (2A) is folded at said double folding portions (2A). As a result, adjacent semiconductor chips (2) mounted on the outer principal surface (first principal surface) of said flexible wiring board (2) are superposed back-to-back, and they are fixed together with adhesive (or adhesive tape) (2B). Said flexible wiring board (2) is further folded at said double folding portions (2A), Au bumps (4) for shortcut wiring connection and lands (4A) for shortcut wiring connection are connected, and the next sets of laminates are layered on. In this way, plural sets of laminates are formed. Said lands (4A) for shortcut wiring connection of wirings having the same function of the laminates and Au bumps (4) for shortcut wiring connection of

the wirings having the same function of the laminates of said plural sets of laminates are electrically connected to reduce the wiring length of said flexible wiring board (2).

[0032]

As shown in Figure 11, in semiconductor device (200) of Application Example 2, solder ball terminals for mounting (common wiring terminals) (7) provided on the inner principal surface (second principal surface) of said flexible wiring board (2) and lands (9A) on assembly substrate (9) for semiconductor device mounting are electrically connected in mounting said device on said mounting substrate (9).

[0033]

In the following, an explanation will be given regarding the method of manufacturing the semiconductor device in Application Example 2. Figure 12 is an outer plan view illustrating the wiring constitution of said flexible wiring board (2). Figure 13 is an inner plan view illustrating the wiring constitution of said flexible wiring board (2). Figure 14 is an overall plan view illustrating the state in which semiconductor chips (1) are mounted on said flexible wiring board (2). Figure 15 is a side view of Figure 14. Figure 16 is a cross section illustrating the state in which one semiconductor chip (1) is mounted on the outer principal surface of said flexible wiring board (2). Figure 17 is a diagram illustrating the state in which flexible wiring board (2) with said semiconductor chips (1) mounting on it is folded to stack said semiconductor chips (1). Figure 18 is an enlarged cross section illustrating the state of connection of the shortcut wiring by folding said flexible wiring board (2) at the double folding portions.

[0034]

In Figures 10-18, (1) represents semiconductor chips (IC chips); (1A) represents the external electrodes of the semiconductor chips (Au bumps on the pads); (2) represents the flexible wiring board (flexible wiring substrate); (2A) represents the double folding portions; (3) represents wiring; (4) represents Au bumps for shortcut wiring connection; 4A represents lands for the shortcut wiring connection; (5) represents via; (6) represents lands for mounting the semiconductor chips; (7) represents solder ball terminals for mounting (external common wiring terminals); (9) represents a mounting substrate; (9A) represents lands for mounting a semiconductor device on the mounting substrate; (10) represents a sealant; (11) represents a flexible board tape; and (12) represents an insulating film (protective film).

[0035]

First of all, flexible wiring board (flexible wiring substrate) (2) is manufactured as shown in Figure 12. As shown in Figure 12, when said flexible wiring board (flexible wiring substrate) (2) is manufactured, wiring is formed on the outer principal surface (first principal surface) of flexible substrate tape (11), with insulating film (protective film) (12) covering it. On the outer principal surface of flexible substrate tape (11) with wiring formed on it as described, wiring (3) for connecting lands (6) for mounting semiconductor chips that have the same function on semiconductor chips (1), lands (4A) for shortcut wiring connection and Au bumps (4) for shortcut wiring connection that connect lands (6) for mounting semiconductor chips and having the same function, of semiconductor chips (1), via (5) for passing said wiring (3) through, and lands (6) for mounting semiconductor chips are formed at their respective positions. On the inner principal surface (second principal surface) of said flexible substrate tape (11), as shown in Figure 13, wiring (3) for connecting lands (6) for mounting semiconductor chips, and having the same function, of semiconductor chips (1), lands (4A) for shortcut wiring connection, as well as Au bumps (4) for shortcut wiring connection and solder ball terminals (7) for mounting are formed.

[0036]

In the method of manufacturing the semiconductor device in Application Example 2, as shown in said Figure 12, flexible wiring board (flexible wiring substrate) (2) is prepared. Then, as shown in Figures 14 and 15, plural semiconductor chips (IC chips) (1) are mounted on lands (6) for carrying semiconductor chips and formed with a prescribed interval on the outer principal surface of said flexible wiring board (2). As shown in Figure 16, semiconductor chips (IC chips) (1) are electrically connected to lands (6) for mounting semiconductor chips by means of external electrodes (Au bumps on the pads) (1A), followed by sealing of the connection region with sealant (sealing resin) (10).

[0037]

As shown in Figure 17, said flexible wiring board (2) having said plural semiconductor chips (1) mounted on it is folded at said double folding portions (2A). As a result, adjacent semiconductor chips (2) mounted on the outer principal surface of said flexible wiring board (2) are superposed back-to-back, and they are fixed together with adhesive (or adhesive tape) (2B). As shown in Figure 17, said flexible wiring board (2) is further folded at said double folding portions (2A), Au bumps (4) for shortcut wiring connection and lands (4A) for shortcut wiring connection are connected, and the next sets of laminates are layered on. In this way, plural sets of laminates are formed.

[0038]

Figures 18(a), (b) show the constitution of said double folded regions. Electrical connection is performed with shortcut wiring portion (2C) of wirings having the same function of the laminates of said plural sets of laminates, so that the wiring length of said flexible wiring board (2) is reduced, and semiconductor device (200) shown in Figure 10 is completed. As shown in Figure 11, for this semiconductor device (200), electrical connection is performed between solder ball terminals (7) for mounting, serving as the external common wiring terminals for wiring having the same function of said laminates, and lands (9A) on assembly substrate (9) for mounting the semiconductor device.

[0039]

As explained above, according to Application Example 2, flexible wiring board (2) that can be folded enables electrical connection among wirings having the same function of the laminates by means of the shortcut wiring portions, and the wiring length of said flexible wiring board (2) is reduced. Consequently, it is possible to prevent signal delay due to the wiring length. Also, in a semiconductor device having a three-dimensional (3D) structure created by folding the wiring board, it is possible to increase the heat dissipation efficiency for the heat generated inside the laminates by means of the shortcut wiring portions for said wirings having the same function of the laminates. Also, it is possible to realize double-sided assembly of IC chips on both surfaces of the board, other than at the solder ball terminal regions for mounting.

[0040]

Application Example 3

The semiconductor device in Application Example 3 of the present invention (semiconductor device (300) or (400)) is another application example similar to said Application Example 2, except that shortcut wiring board (8) in Application Example 1 is omitted here. Figures 19 and 20 illustrate the folding structure ((300) and (400)). The manufacturing method is the same as that of said Application Examples 1 and 2.

[0041]

Application Example 4

Figure 21 includes a plan view, a lateral cross section and a longitudinal cross section illustrating schematically the constitution of the semiconductor device in Application Example 4 of the present invention. Figure 22 is a lateral cross section illustrating the state in which the semiconductor device of Application Example 4 is mounted on a mounting substrate. As shown

in Figure 21, in the semiconductor device of Application Example 4, plural semiconductor chips (IC memory chips) (1) are mounted at prescribed intervals on the outer principal surface (first principal surface) of flexible wiring board (63) having quarter folding portions (2A). The flexible wiring board is double folded at said double folding portions of said flexible wiring board (63), so that semiconductor chips (1) mounted on the outer principal surface of said flexible wiring board (63) are superposed back-to-back, and are fixed together with adhesive (or adhesive tape). Said flexible wiring board (63) is then quarter folded at said quarter folding portions, and the next sets of laminates are layered on. In this way, plural sets of laminates are formed. Electrical connection is made between lands (61) for shortcut wiring connection of wirings having the same function of the laminates of said plural sets of laminates and solder ball terminals (62) for shortcut wiring, and the wiring length of said flexible wiring board (63) is reduced. Relief hole (26) for relieving the folding stress is formed at the center of said flexible wiring board (63).

[0042]

As shown in Figure 22, semiconductor device (500) of Application Example 4 is mounted on said mounting substrate (9), with electrical connection being made between solder ball terminals (common wiring terminals) (7) for mounting, provided on the inner principal surface (second principal surface) of said flexible wiring board (63), and lands (9A) of mounting substrate (9) for semiconductor device mounting.

[0043]

In the following, an explanation will be given regarding the method of manufacturing the semiconductor device in Application Example 4. Figure 23 is an outer plan view illustrating the wiring constitution of said flexible wiring board (63). Figure 24 is an inner plan view illustrating the wiring constitution of said flexible wiring board (63). Figure 25 is an overall plan view illustrating the state in which semiconductor chips (1) are mounted on said flexible wiring board (63). Figure 26 is a side view of Figure 25. Figure 27 is a cross section illustrating the state in which one semiconductor chip (1) is mounted on the outer principal surface of said flexible wiring board (63). Figure 28 includes a plan view, a lateral cross section, and a longitudinal cross section of double folded flexible wiring board (63) carrying said semiconductor chips (1). Figure 29 is a plan view of the quarter folded flexible wiring board (63) carrying said semiconductor chips (1).

[0044]

In Figures 21-29, (1) represents semiconductor chips (IC chips); (1A) represents the external electrodes of the semiconductor chips (Au bumps on the pads); (3) represents wiring; (6)

represents lands for mounting the semiconductor chips (external common wiring terminals); (7) represents a solder ball terminal for mounting; (9) represents a mounting substrate; (9A) represents lands for mounting semiconductor device on the mounting substrate; (10) represents a sealant; (12) represents an insulating film (protective film); (5) represents via; (17) represents minute (buildup) via; (26) represents a relief hole for relieving the folding stress; (61) represents lands for shortcut connection wiring; (62) represents solder ball terminals for shortcut wiring; and (63) represents a flexible wiring board (flexible wiring substrate) with wiring formed on a polyimide tape.

[0045]

First, flexible wiring board (63) is manufactured as shown in Figure 21. As shown in Figures 23 and 24, when said flexible wiring board (63) is manufactured, wiring is formed on flexible wiring board (63), with an insulating film (protective film) covered on it. On the outer principal surface (first principal surface) of flexible wiring board (63), wiring (3) for connecting lands for mounting semiconductor chips that have the same function on semiconductor chips (1), lands (61) for shortcut wiring connection for connecting the lands for mounting semiconductor chips that have the same function on semiconductor chips (1), bumps of solder ball terminals (62) for shortcut wiring, and lands (6) for mounting semiconductor chips are formed at their respective positions. As shown in Figure 24, wiring (3) for connecting the lands for mounting semiconductor chips that have the same function on semiconductor chips (1), lands 61 for shortcut wiring connection, Au bumps (62) for shortcut wiring connection, and solder ball terminals (7) for mounting are formed on the inner principal surface (second principal surface) of said flexible substrate tape (63).

[0046]

In the method of manufacturing the semiconductor device in Application Example 4, as shown in Figures 23 and 24, flexible wiring board (63) is prepared. Then, as shown in Figures 25 and 26, plural semiconductor chips (IC chips) (1) are mounted on the lands for mounting semiconductor chips and formed at prescribed intervals on the outer principal surface of said flexible wiring board (63). As shown in Figure 27, semiconductor chips (IC chips) (1) are electrically connected to the lands for mounting semiconductor chips by means of external electrodes (Au bumps on the pads) (1A), followed by sealing of the connection region with a sealant (sealing resin).

[0047]

When multi-layer wiring is needed, as shown in Figure 27, a buildup system or the like is adopted for flexible wiring board (63), so that it is possible to form a flexible wiring board (63) having both multi-layer wiring portions that allow high-density wiring (the portion from the left side in the figure to immediately before the thinnest portion to the right of center, and the portion that becomes thicker on the right side) and a foldable portion with single-sided or double-sided mono-layer wiring (the thinnest portion positioned between said multi-layer wiring portions).

[0048]

As shown in Figure 28, said flexible wiring board (63) having said plural semiconductor chips (1) mounted on it is double folded at said double folding portions (2A). As a result, adjacent semiconductor chips (1) mounted on the outer principal surface of said flexible wiring board (63) are superposed back-to-back, and they are fixed together with an adhesive (or adhesive tape). In addition, as shown in Figure 29, said flexible wiring board (63) is quarter folded at said quarter folding portions (2A), and the next sets of laminates are layered. In this way, as shown in Figure 21, plural sets of laminates having semiconductor chips (1) superposed back-to-back are formed. Wirings having the same function of said laminates of said plural sets of laminates are electrically connected by means of short circuit electrodes for creating a shortcut, so that the wiring length of said flexible wiring board (63) is reduced.

[0049]

As shown in Figure 22, semiconductor device (500) of Application Example 4 is assembled on said mounting substrate (9), with electrical connection between external electrodes (7) for mounting, serving as common terminals, provided on the inner principal surface (second principal surface) of said flexible wiring board (63) and lands (9A) of mounting substrate (9) for mounting a semiconductor device. Also, when the folding stress is high, a relief hole (26) for relieving the folding stress can be provided. Also, it is possible to use double-sided mounting of the IC chip on the two surfaces of the board, other than at the solder ball terminal regions for mounting.

[0050]

Application Example 5

Figure 30 is a cross section schematically illustrating the state in which the heat absorptive pad of the semiconductor device in Application Example 5 of the present invention is accommodated in the package. Figure 31 is a plan view schematically illustrating the state in which the heat absorptive pad shown in Figure 30 is accommodated in the package. Figure 32 is

a schematic diagram illustrating the constitution of the cooling mechanism with the heat absorptive pad shown in Figure 30.

[0051]

In Figures 30-32, (1) represents semiconductor chips (IC chips); (1A) represents the external electrodes of the semiconductor chips (Au bumps on the pads); (7) represents solder ball terminals for mounting (external common wiring terminals); (26) represents a relief hole for relieving the folding stress; (61) represents lands for shortcut connection wiring; (62) represents solder ball terminals for shortcut wiring; (63) represents a flexible wiring board (flexible wiring substrate) with wiring formed on a polyimide tape; (64) represents a heat absorptive pad; (65) represents a pipe; (66) represents a flow path; (67) represents a fan; (68) represents a heat dissipating part (radiator); (69) represents heat dissipating fins; (70) represents a coolant circulation pump; (71) represents a folded laminated package; and (72) represents a thermoconductive adhesive tape.

[0052]

For the semiconductor device of Application Example 5 of the present invention, laminating is realized by means of cross folding in addition to the bellows folding, double folding and triple [sic; quarter] folding in the aforementioned application examples. As shown in Figures 30 and 31, flexible wiring board (63) (flexible wiring substrate) is quarter folded to laminate semiconductor chips (1). Relief hole (26) for relieving the folding stress is provided at the center of flexible wiring board (63) where the stress is concentrated in cross folding.

[0053]

That is, the semiconductor device has flexible wiring board (63), which has quarter folding portions and relief hole (26) for relieving the folding stress at the center, and which can carry plural semiconductor chips (1) at prescribed intervals on its surface, and plural sets of laminates of semiconductor chips (1) mounted on the outer surface of flexible wiring board (63) and superposed back-to-back when said flexible wiring board (63) is double folded at said double folding portions. Plural semiconductor chips (IC chips) (1) are mounted at the prescribed positions on the outer principal surface of said flexible wiring board (63), and said flexible wiring board (2) is quarter folded at said folding portions (2A), so that semiconductor chips (1) mounted on the outer surface of said flexible wiring board (63) are superposed back-to-back, and are fixed together with adhesive (or adhesive tape) (2B). In addition, said flexible wiring board (63) is quarter folded at said folding portions (2A), and the next set of laminates are layered. In this way, plural sets of laminates are obtained.

[0054]

The thickness of the flexible tape substrate for use in preparing said flexible wiring board (63) may be 75 μm, and the thickness of the Cu wiring may be 35 μm. Wirings having the same function of the laminates of said plural sets of laminates are electrically connected by short circuit electrodes that provide a shortcut, and the wiring length of said flexible wiring board (63) is reduced.

[0055]

As shown in Figures 30 and 31, heat absorptive pad (cooling path) (64) is provided between the laminates with said semiconductor chips superposed. As shown in Figures 30 and 31, said heat absorptive pad (cooling path) (64) is formed with flow path (66). Said heat absorptive pad (cooling path) (64) is fixed by means of thermoconductive adhesive tape (72) between the laminates with said semiconductor chips superposed in a folded stacked laminate package (71).

[0056]

Also, said heat absorptive pad (64) has flow path (66) inside the insulating ceramics or the like used in the IC package. Said flow path (66) goes through pipe (65) and is connected to heat dissipating part (68), and it is filled with water or other liquid. Attachment of heat absorptive pad (64) is performed by means of thermoconductive adhesive tape (72). Also, silicon grease together with an adhesive material can be used for even better performance. Coolant circulating pump (70) force-circulates the internal liquid, and the heat absorbed with heat absorptive pad (64) is transported, with the circulating liquid serving as a medium, through pipe (65) to heat dissipating part (68), and is subjected to forced cooling by fan (67). The liquid cooled in heat dissipating part (68) passes through pipe (65) back to heat absorptive pad (64). Also, a heat pipe, heat dissipating plate, or the like can be incorporated, or a heat sink attached.

[0057]

When multi-layer wiring is needed, as shown in Figure 27, a buildup system or the like is adopted for flexible wiring board (63), so that it is possible to form a flexible wiring board (63) having both multi-layer wiring portions that allow high-density wiring (the portion from the left side in the figure to immediately before the thinnest portion to the right of the center, and the portion that becomes thicker on the right side) and the foldable portion with the single-sided or double-sided mono-layer wiring (the thinnest portion positioned between said multi-layer wiring portions).

[0058]

Said buildup multi-layer wiring portion can be prepared as follows: Wiring (3) is formed with copper or another electroconductive substance on polyimide tape (flexible substrate) (63), followed by laminating insulating photosensitive resin (18). Then, by means of exposure, fine (buildup) via (17) is opened, while the remaining portion is cured to form an insulating layer, and wiring (3) is formed of copper or other electroconductive substance. Consequently, it can be manufactured using the same method as minute (buildup) via (17) even for the foldable portion of a mono-layer wiring.

[0059]

In Application Examples 1-5, the manufacturing method makes use of bare chip assembly by means of Au bumps. However, other manufacturing methods may also be adopted, such as wiring bonding, beam leads, etc. Also, in said application examples, the semiconductor device and its manufacturing method have been explained. However, as can be seen from the aforementioned explanation, the present invention is also applicable to a semiconductor module and its manufacturing method.

[0060]

In the above, the present invention has been explained with reference to application examples. However, the present invention is not limited to the aforementioned application examples. Various modifications are allowed as long as the gist of the present invention is observed.

[0061]

Effect of the invention

The following is a brief account of the effect of the invention disclosed in the present patent application. According to the present invention, in a semiconductor device or semiconductor module with a three-dimensional (3D) structure created by folding a flexible wiring board, short circuit electrodes that provide wiring shortcuts are used for electrical connection so as to reduce the wiring length. Consequently, it is possible to prevent signal delay due to the wiring length. Also, by providing a heat absorptive pad (cooling path) between the laminates when said semiconductor chips are superposed, it is possible to increase the heat dissipation efficiency.

Brief description of the figures

Figure 1 is a front view schematically illustrating the constitution of the semiconductor device in Application Example 1 of the present invention.

Figure 2 is a front view of the semiconductor device of Application Example 1 assembled on a mounting substrate.

Figure 3 is an outer plan view illustrating the wiring constitution of the flexible wiring board in Application Example 1.

Figure 4 is an inner plan view illustrating the wiring constitution of the flexible wiring board of Application Example 1.

Figure 5 is an overall plan view illustrating the state in which the semiconductor chips are mounted on the flexible wiring board of Application Example 1.

Figure 6 is a side view of Figure 5.

Figure 7 is a cross section illustrating the state in which a semiconductor chip is mounted on the flexible wiring board in Application Example 1.

Figure 8 is a plan view illustrating the constitution of the wiring board serving as one and the other shortcut wiring boards in Application Example 1.

Figure 9 is a diagram illustrating the state in which one of the shortcut wiring boards is connected to the wiring of the flexible wiring board in Application Example 1.

Figure 10 is a front view schematically illustrating the semiconductor device in Application Example 2 of the present invention.

Figure 11 is a front view of the semiconductor device mounted on the mounting substrate in Application Example 2.

Figure 12 is an outer plan view illustrating the wiring constitution of flexible wiring board (2) in Application Example 2.

Figure 13 is an inner plan view illustrating the wiring constitution of the flexible wiring board in Application Example 2.

Figure 14 is an overall plan view illustrating the state in which the semiconductor chips are mounted on the flexible wiring board in Application Example 2.

Figure 15 is a side view of Figure 14.

Figure 16 is a cross section illustrating the state in which a semiconductor chip is mounted on the flexible wiring board in Application Example 2.

Figure 17 is a diagram illustrating the state in which the flexible wiring board having semiconductor chips mounted on it is folded in Application Example 2.

Figure 18 is an enlarged cross section illustrating the state in which the flexible wiring board is folded at the double folding portions of the flexible wiring board in Application Example 2.

Figure 19 includes a front view, plan view, and side view illustrating schematically the constitution of the semiconductor device in Application Example 3 of the present invention.

Figure 20 is a front view schematically illustrating the constitution of the semiconductor device in Application Example 3.

Figure 21 includes a plan view, a lateral cross section and a longitudinal cross section illustrating schematically the constitution of the semiconductor device in Application Example 4 of the present invention.

Figure 22 is a lateral cross section of mounting of the semiconductor device on the mounting substrate in Application Example 4.

Figure 23 is an outer plan view illustrating the wiring constitution of the flexible wiring board in Application Example 4.

Figure 24 is an inner plan view illustrating the wiring constitution of the flexible wiring board in Application Example 4.

Figure 25 is an overall plan view illustrating the state in which semiconductor chips are mounted on the flexible wiring board in Application Example 4.

Figure 26 is a side view of Figure 25.

Figure 27 is a cross section illustrating the state in which a semiconductor chip is mounted on said flexible wiring board (when a multi-layer wiring is adopted) in Application Example 4.

Figure 28 includes a plan view, a lateral cross section and a longitudinal cross section of the double folded flexible wiring board having semiconductor chips mounted on it in Application Example 4.

Figure 29 is a plan view of the quarter folded flexible wiring board having semiconductor chips mounted on it in Application Example 4.

Figure 30 is a cross section schematically illustrating the state in which the heat absorptive pad of the semiconductor device is accommodated in the package in Application Example 5 of the present invention.

Figure 31 is a plan view schematically illustrating the state in which the heat absorptive pad is accommodated in the package in Application Example 5.

Figure 32 is a schematic diagram schematically illustrating the constitution of the cooling mechanism using the heat absorptive pad in Application Example 5.

Explanation of reference symbols

1 Semiconductor chip (IC chip)

1A External electrodes of semiconductor chip

2 Flexible wiring board

2A Folding portion
2B Adhesive for semiconductor chip
2C Shortcut wiring connecting portion
3 Wiring
4 Au bump for shortcut wiring connection
4A Land for shortcut wiring connection
5 Via
6 Land for mounting semiconductor chip
7 Solder ball terminal for mounting
8A, 8B Shortcut wiring board
9 Mounting substrate
9A Land for mounting of semiconductor device
10 Sealant
11 Flexible substrate tape
12 Insulating film (protective film)
17 Minute (buildup) via
18 Insulating photosensitive resin
22 Adhesive tape
23 Solder
26 Relief hole for relieving the folding stress
61 Land for shortcut wiring connection
62 Solder ball terminal for shortcut wiring
63 Flexible wiring board
64 Heat absorptive pad
65 Pipe
66 Flow path
67 Fan
68 Heat dissipating part (radiator)
69 Heat dissipating fins
70 Coolant circulating pump
71 Folding laminated package
72 Thermoconductive adhesive tape

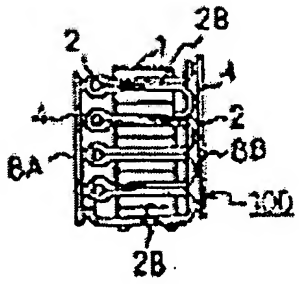


Figure 1

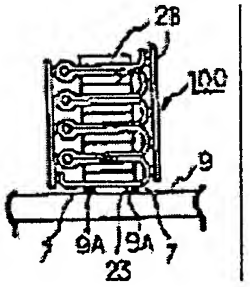


Figure 2

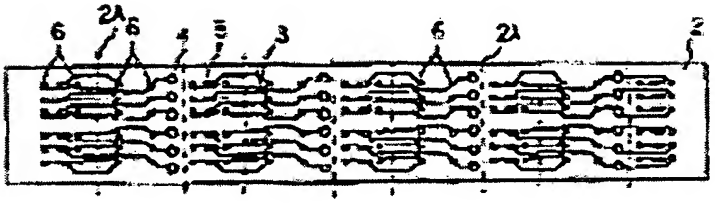
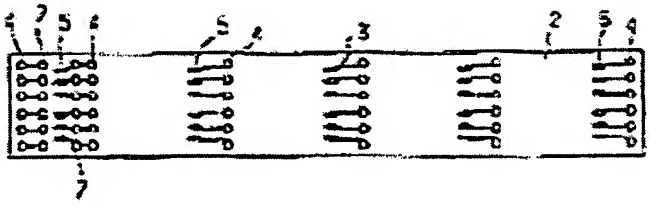


Figure 3



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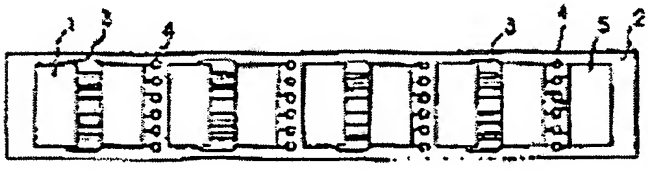
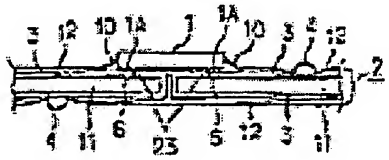


Figure 5

Figure 6



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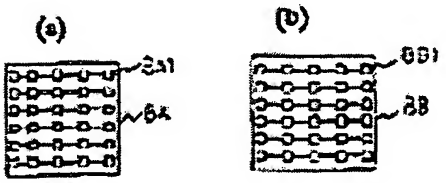

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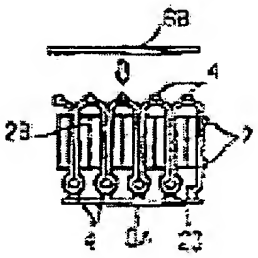

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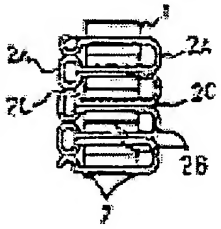

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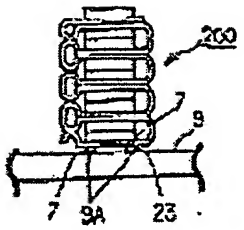

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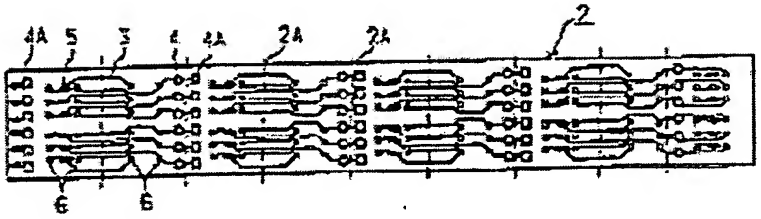

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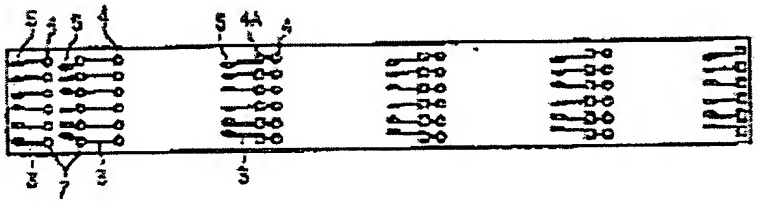
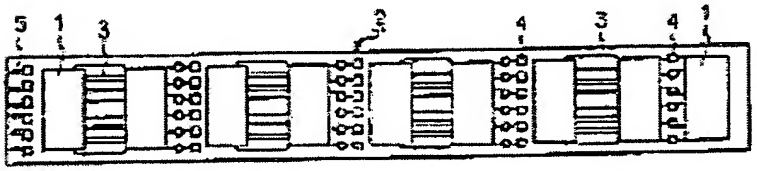


Figure 13



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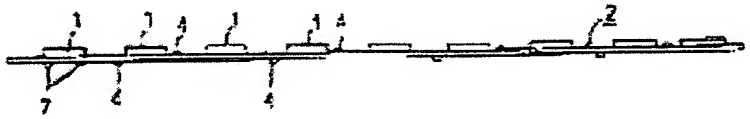

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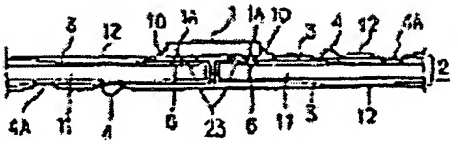
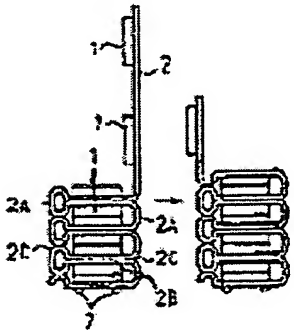


Figure 16



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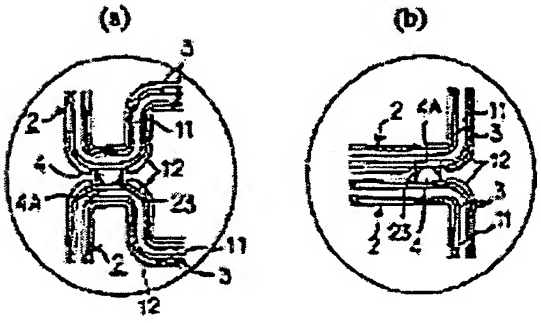

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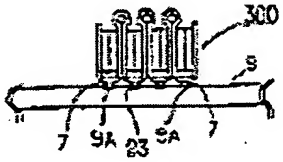

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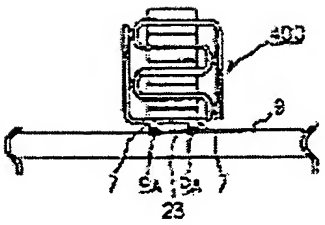

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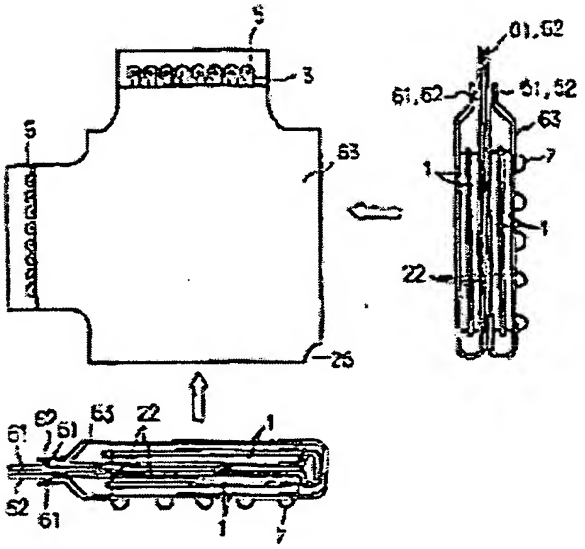

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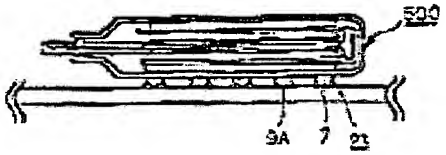

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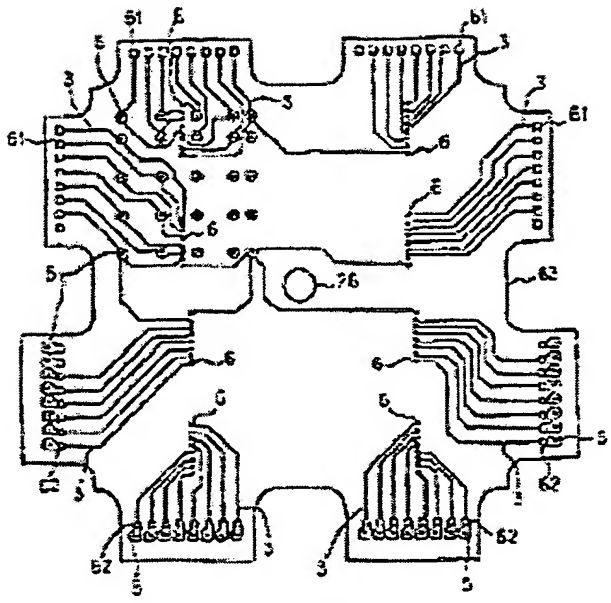

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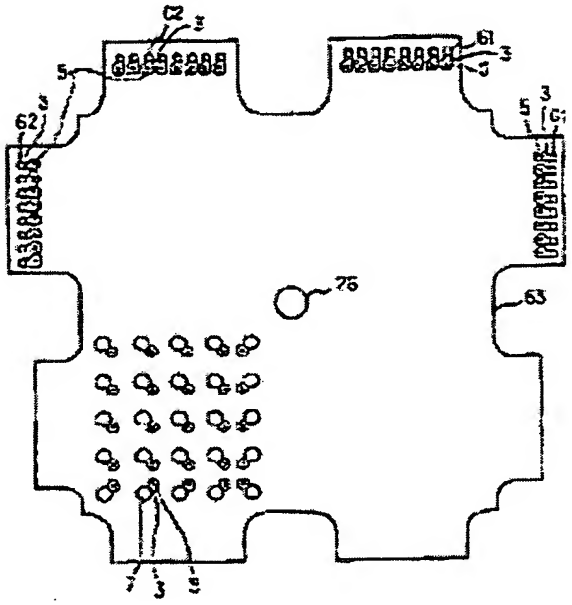

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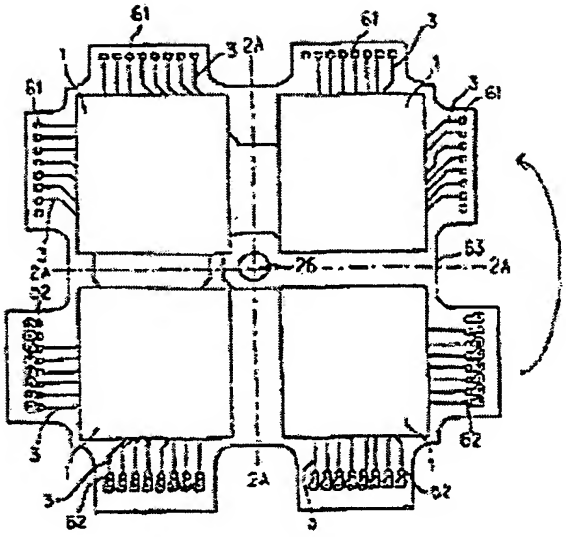

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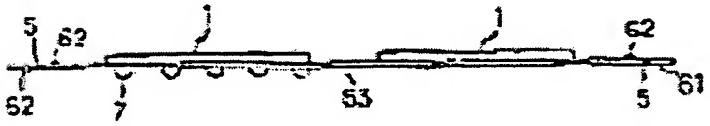

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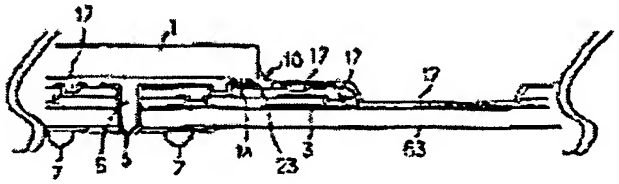

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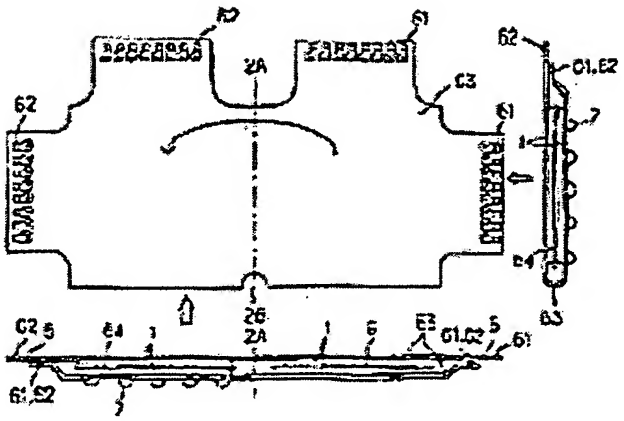

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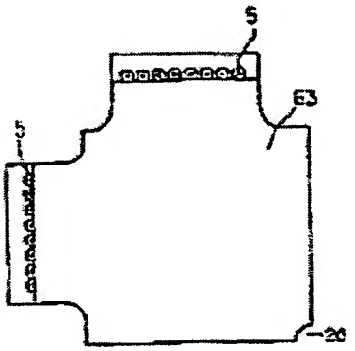

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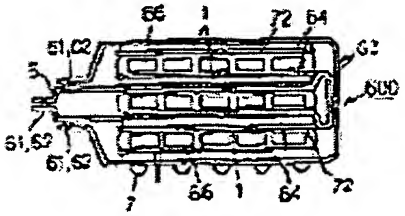

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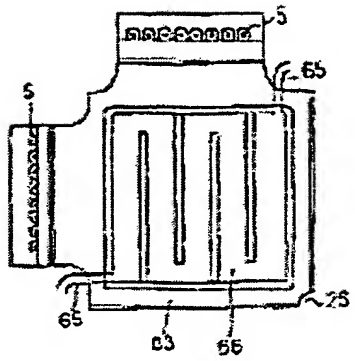

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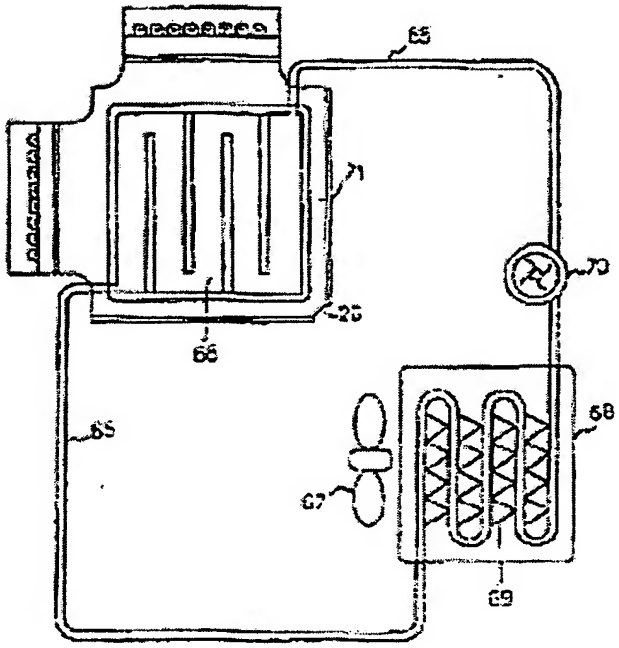

Figure 32